BULLETIN

OF THE INSTITUTE OF METALS

VOLUME 4 MAY 1958 PART 9

INSTITUTE NEWS

Election of Members

The following 1 Overseas Sustaining Member, 23 Ordinary Members, 1 Junior Member, and 13 Student Members were elected on 1 April 1958:

As Overseas Sustaining Member

EMCO, LTD., Box 698, London, Ont., Canada.

As Ordinary Members

ALEXANDER, John Malcolm, Ph.D., B.Sc., D.I.C., A.C.G.I., A.M.I.Mech.E., Reader in Plasticity, Imperial College of Science and Technology, London, S.W.7.

ANGUS, Hamish Carmichael, M.Sc., Physicist, The Mond Nickel Co., Ltd., Bashley Road, London, N.W.10.

BUSCH, Lee S., B.S., Technical Director, Mallory-Sharon Metals Corp. 980 Warren Avenue, Niles, Ohio, U.S.A.

COCKSHUTT, John Raymond, B.Sc., Works Manager, Engelhard Industries, Ltd., Baker Platinum Division, 154–170 Vauxhall Street, London, S.E.11.

CONNOR, Henry, B.Sc., Technical Sales Consultant, Johnson, Matthey and Co., Ltd., Hatton Garden, London, E.C.1.

EVERSHED, Alfred Victor, B.Sc., Scientific Officer, Metal Physics Section, British Iron and Steel Research Association, 140 Battersea Park Road, London, S.W.11.

FECHT, Otto Rudolf Friedrich, Dipl. Ing., Leiter der Materialprüfung, Siemens-Schuckert-Werke A.G., Nonnendamm-Allee 110, Berlin-Siemensstadt, Germany.

GILLEMOT, *Professor* László, Dr.techn.sci., Dipl. Ing., Director, Industrial Research Institute of Metals, Technical University, Bertalan-utica 7, Budapest XI, Hungary.

GORDON, James Roycroft, B.Sc., Hon.LL.D., Executive Vice-President, The International Nickel Company of Canada, Ltd., 67 Wall St., New York, 5, N.Y., U.S.A.

GOUSSELAND, Pierre Léopold Jean, Ing.civ.Mines, Foreign Development Manager, American Metal Climax Inc., c/o Climax Molybdenum Co., 1 avenue de l'Observatoire, Paris 6e, France.

GRAHAM, Ronald Alexander, L.I.M., Process Engineer (Heat-Treatment), Caterpillar Tractor Co., Ltd., P.O. Box 162, Glasgow.

HAHN, Rolf, Dr.rer.nat., Dipl.phys., Ingénieur, Métaux Précieux, Neuchâtel, Switzerland.

HILL, Douglas Albert, B.Sc., Production Metallurgist, McKechnie Brothers, Ltd., Middlemore Lane, Aldridge, Staffs.

KELLAWAY, F. W., B.Sc., Principal, North Herts Technical College, Broadway, Letchworth, Herts.

LJUNGBERG, Rolf Ivan Torvald, Head of Development of Powder Metallurgy and Special Products, Husqvarna Vapenfabriks A.B., Husqvarna, Sweden.

OLSEN, Torkil, M.A., Librarian, Danish Atomic Energy Commission, Risö pr. Roskilde, Denmark.

READ, *Professor* Harold James, M.S., Ph.D., Professor of Physical Metallurgy, Pennsylvania State University, University Park, Pa., U.S.A.

RIBCHESTER, Leonard, Foundry Manager, Emco Brass Manufacturing Co., Ltd., Margate, Kent.

SMELLIE, William James, B.Sc., Ph.D., A.R.S.M., Chief Metallurgist, The Sheffield Smelting Co., Ltd., Royds Mill Street, Sheffield 4.

SPERRY, Philip Roger, B.S., Project Engineer, Aluminum Technical Center, Metallurgical Laboratories, Olin Mathieson Chemical Corp., 275 Winchester Ave., New Haven 4, Conn., U.S.A.

SPROWL, John D., B.Sc., M.S.E., Research Engineer, Kaiser Aluminum and Chemical Corp., Department of Metallurgical Research, Spokane 65, Wash., U.S.A.

WALLWORK, Greig Richard, B.Sc., A.S.T.C., A.I.M., Lecturer, School of Metallurgy, New South Wales University of Technology, Kensington, Sydney, N.S.W., Australia.

ZVANUT, Carl M., B.S., Development Engineer, The Dow Chemical Co., Madison Division, Madison, Ill., U.S.A.

As Junior Member

CARTER, Anthony Brian, Assistant Metallurgist, Standard Telephones and Cables Co., Ltd., Oakleigh Road, New Southgate, London, N.11.

As Student Members

AYLMORE, David Willis, B.Sc., Research Student, Washington Singer Laboratories, University of Exeter.

BEDDOES, Lawrence Picken, A.C.T. (Birm.), L.I.M., Metallurgist, Richard Thomas and Baldwins, Ltd., Stourvale Works, Kidderminster, Worcs.

CASSINGHAM, Robin James, Laboratory Assistant, British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1.

FINCH, Cabell Braden, B.A., Undergraduate Student of Metallurgical Engineering, Texas Western College, El Paso, Texas, U.S.A.

GRETZ, Ronald David, B.S., Graduate Student, Department of Metallurgy, Carnegie Institute of Technology, Pittsburgh 13, Pa., U.S.A.

HARVEY, Michael William, Undergraduate, Department of Metallurgy, University of Cambridge.
HECKEL, Richard Wayne, M.S., General Motors Corp. Fellow, Department of Metallurgical Engineering, Carnegie Institute of Technology, Pittsburgh 13, Pa., U.S.A.
HOGG, James Sinclair, Student of Metallurgy, Royal College of Science and Technology, Glasgow.
LINDLEY, Trevor Charles, Undergraduate, Department of Metallurgy, University of Birmingham.
LUTLEY, John Herbert, Undergraduate, Department of Metallurgy, University of Cambridge.
MURRELL, Donald Leonard, Assistant (Scientific), Post Office Research Station, Dollis Hill, London, N.W.2.
NEWMAN, John Ward Spencer, Undergraduate, Royal School of Mines, London, S.W.7.
WOOTTON, George Claude, B.A.Sc., Graduate Student, Department of Mining and Metallurgy, University of British Columbia, Vancouver 8, B.C., Canada.

PERSONAL NOTES

MR. P. H. BRACE has been appointed Assistant Professor of Physics at Illinois Wesleyan University. He was previously consulting metallurgist with Westinghouse Research Laboratories, Pittsburgh, Pa.

MR. A. R. COOK has left the Northern Aluminium Co., Ltd., and is now with the American Zinc Institute, New York.

DR. C. R. CUPP has left Canadian Westinghouse Co., Ltd., to join The International Nickel Co., Inc.

MR. P. D. FROST, Chief of the Light Metals Division at Battelle Memorial Institute, has received the 1957 Achievement Award of the Metal Testing Institute for a paper on the heat-treatment of titanium.

MR. J. F. GARDNER has been appointed Northern Area Representative of Refractory Mouldings and Castings, Ltd., Kegworth, near Derby.

MR. D. GEISELMAN has joined the staff of the Metals Research Laboratories of Electro Metallurgical Co., Niagara Falls, N.Y.

DR. J. B. HAWORTH has left Sherritt Gordon Mines, Ltd., and has been appointed Metallurgist to the Fluor Corp., Los Angeles.

MR. J. F. B. JACKSON has been appointed Managing Director of A.P.V.-Paramount, Ltd., Crawley. He joined the Board in 1954.

MR. L. MARSHALL has left Electro-Hydraulics, Ltd., to join Hughes-Johnson Stampings, Ltd., Oldbury.

PROFESSOR C. H. MATTHEWSON has been elected to Honorary Membership of the American Institute of Mining, Metallurgical, and Petroleum Engineers.

DR. H.W. PAXTON has been appointed to the newly established Firth Sterling Chair of Metallurgical Engineering at the Carnegie Institute of Technology, Pittsburgh, Pa.

PROFESSOR F. N. RHINES, of the Carnegie Institute of Technology, has been awarded the Henry Marion Howe Medal of the American Society for Metals.

PROFESSOR A. J. SHALER, Head of the Metallurgy Department at Pennsylvania State College, has received the annual Metallurgy Teaching Award of the American Society for Metals for 1957.

DR. F. T. SISCO, Director of the Engineering Foundation, has been appointed Chairman of a new committee of the American Society for Metals dealing with Metallurgical Documentation.

DR. J. F. THOMPSON, Chairman of the Board of International Nickel Co. of Canada, Ltd., has received the Charles F. Rand Memorial Medal for 1958. It was awarded by the American Institute of Mining, Metallurgical, and Petroleum Engineers in recognition of his distinguished achievements in mining administration.

MR. W. M. WILLIAMS has left Cardiff Technical College to take up an appointment in the Department of Metallurgical Engineering, University of Toronto.

DR. C. ZENER, Director of the Westinghouse Research Laboratories, Pittsburgh, has been awarded the Bingham Medal of the Society of Rheology for his researches into metals.

PROFESSOR O. ZMESKAL has left the University of Florida to become Dean of the College of Engineering, University of Toledo, Toledo 6, Ohio.

LETTERS TO THE EDITOR

Kinetics of Recovery of Cold-Worked Cadmium from Internal-Friction and Elasticity Measurements

It has already been shown [1] that the process of recovery from cold work in metals during annealing is controlled by some type of kinetic reaction. The study of the kinetics of recovery by annealing has generally been approached by measuring changes in structure-sensitive physical properties, such as resistivity,[2] hardness,[3] and lattice parameters,[4] or by isothermal calorimetric measurements.[5, 6] The purpose of the present investigation was to determine how far internal friction and elasticity might be used to follow the course of the recovery process and its kinetics.

High-purity polycrystalline cadmium was received in the form of a short cylinder of 3 cm. dia., and was given a long anneal at 280° C. before being heavily cold worked by swaging to provide rectangular strip samples (breadth 0·1 cm., thickness 0·05 cm.) having an initial standard history.

Internal friction, Q^{-1}, was measured by the resonance-curve method, using clamped/free wire samples. Transverse vibrations with maximum strain amplitude of 10^{-7} at frequencies of about 70 cycles/sec. were set up electrostatically *in vacuo* and were detected and measured by a micro-vibration pick-up which has previously been described.[7] Young's modulus, E, was determined simultaneously. The square of frequency of vibration was taken as a measure of elasticity.

Annealing was carried out by subjecting the specimen to heat pulses of known magnitude; frequency and isothermal damping measurements at 25° C. were then made. The heat pulse was produced by introducing the sample into an electric furnace (with an adequate heat capacity) previously maintained at the desired annealing temperature. The temperature variation inside the furnace did not exceed $\pm 0{\cdot}5°$ C. at the highest

annealing temperature of 140° C., as indicated by a Chromel/Alumel thermocouple which was used to explore the temperature inside the furnace. A correction for the non-precise ends of the given heat pulse, as calculated from the heating curve of the test wire, was found to be negligibly small compared with the annealing times used.

The relative isothermal internal friction and elasticity were measured for an initially cold-worked cadmium sample which had been given various known heat pulses. The course of the recovery process was followed by measuring the internal friction and the elastic modulus, which are structure-sensitive physical properties and can be used to assess the degree of cold work in the sample after a given heat pulse.

The relative isothermal internal friction, Q^{-1}/Q_0^{-1}, and the relative elasticity E/E_0 (Q_0^{-1} and E_0 being the internal friction and Young's modulus at zero annealing time, respectively) were plotted against the annealing time, t, for several constant annealing temperatures between 70° and 140° C. The value of Q_0^{-1} at zero annealing time was the same in all cases, being about 0·035. Typical results are shown in Fig. 1. The internal friction of the sample was found to decrease as recovery proceeded, tending to an equilibrium value which depended upon the annealing temperature. The rate of recovery, as determined from the decrease in internal friction and the associated increase in elasticity, becomes more pronounced as the annealing temperature is raised. It is apparent from Fig. 1

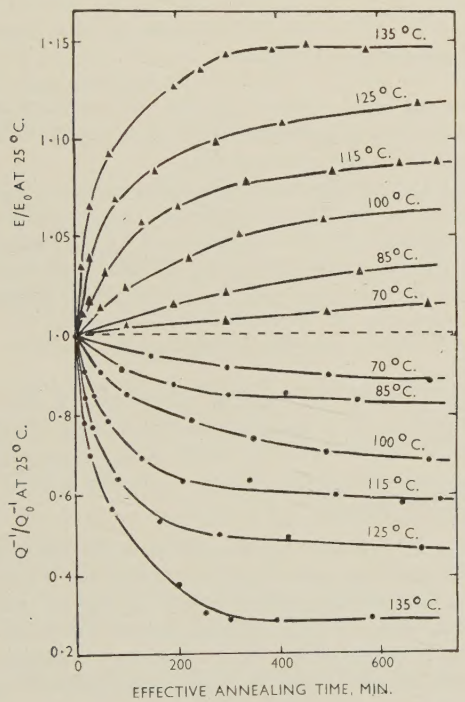

FIG. 1.—Relative isothermal internal friction and Young's modulus versus time curves for recovery in cold-worked cadmium.

that during recovery the curves showing modulus relaxation are mirror images of the internal-friction curves.

Using the isothermal data of Fig. 1, cuts were made at various values of Q^{-1}/Q_0^{-1} and E/E_0. For each cut the logarithm of time required to reach that value was plotted against the corresponding reciprocal of absolute temperature (T° K.) of annealing. The almost parallel straight lines obtained from different cuts, shown in Fig. 2, indicate that the recovery process satisfies the equation:

$$t \exp(-H/RT) = \text{constant},$$

where H is the heat of activation and R the gas constant.

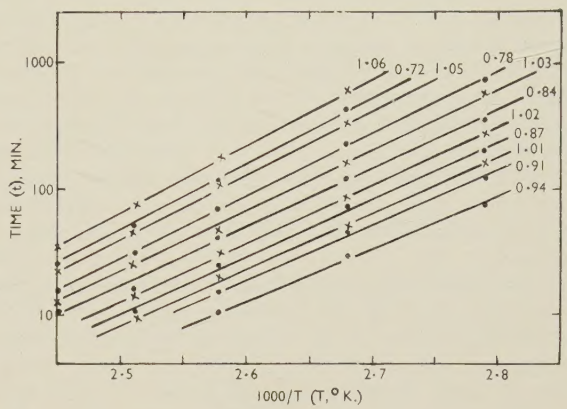

FIG. 2.—Equivalent times and temperatures for the recovery process in cold-worked cadmium. Average activation energy = 21·6 k.cal./mole.

The value of activation energy as calculated from the average slope of the lines was 21·6 k.cal./mole, with a standard deviation of 4·4%.

The first stage of recovery previously assumed by Beck [8] is brought about by low-temperature annealing. It seems that after a given heat pulse, lattice distortion disappears as the dislocations leave the piled-up groups by gliding on their slip planes.[6] Accordingly, the present activation energy is associated with internal strain relaxation resulting from the dissolution of dislocations.

A consideration of the slopes of the lines (Fig. 2) indicates that the activation energy shows a slight but noticeable increase as the recovery process takes place at higher temperatures. The observed dependence of activation energy on the recovery-temperature range is thought to be due to some other relaxation process which begins to come into action as the annealing temperature is raised.

Finally, it is worth mentioning that the present technique for analysing the data does not depend on a knowledge of the relationship between lattice distortion and the property measured.

R. KAMEL
E. A. ATTIA

Physics Department,
University of Cairo.

REFERENCES

1. A. H. Cottrell and V. Aytekin, *J. Inst. Metals*, 1950, **77**, 389.
N. F. Mott, *Proc. Phys. Soc.*, 1951, [B], **64**, 729; *Phil. Mag.*, 1953, [vii], **44**, 753.
2. D. Bowen, R. R. Eggleston, and R. H. Kropschot, *J. Appl. Physics*, 1952, **23**, 630.
3. T. Ll. Richards, S. F. Pugh, and H. J. Stokes, *Acta Met.*, 1956, **4**, 75.
4. B. F. Decker and D. Harker, *Trans. Amer. Inst. Min. Met. Eng.*, 1950, **188**, 887.
5. G. Borelius, S. Berglund, and S. Sjöberg, *Arkiv Fysik*, 1953, **6**, 143.
6. H. U. Åström, *ibid.*, 1956, **10**, 197.
7. R. Kamel, *J. Appl. Physics*, 1953, **24**, 1308.
8. P. A. Beck, *Acta Met.*, 1953, **1**, 422.

The Extrapolation of the Stress-Rupture Properties of Nimonic Alloys

In his recent paper,[1] Dr. Betteridge compares the results of various methods of extrapolation, including a method attributed to the present authors. Although in the two papers quoted by him (References 4 and 6 of his paper) and in other unpublished papers, we show that a variety of creep data for a range of times is satisfactorily co-ordinated by the general principles he correctly attributes to us, we have not advocated their use for extrapolation, in view of the many pitfalls, until a suitable method of application had been both developed and experimentally confirmed. This has now been done by K. F. A. Walles, and a paper for publication is being prepared.

The success of the developed method depends upon extracting more information from the experimental data than is extracted by the method used by Dr. Betteridge. The developed method gives an average deviation similar to that quoted in his Table III for the Manson and Haferd method. The deviation appears to lie, as in other applications, within the experimental scatter. The Manson and Haferd method suffers, of course, from the objection, to which many authors have referred, that the straight lines on a log t versus T plot for the different stresses do not usually converge to an unambiguous common intersection. They do not so converge for the data for one of the materials of the paper. This method, like the Larson and Miller and Dorn methods, is also known to fail badly in specific instances, and we are therefore bound to conclude that the small deviation found in Table III for the Manson and Haferd method is fortuitous. With this reservation, however, we are not in serious disagreement with the extrapolated values recommended in the paper.

Reference 6 of the paper, together with Report No. R190, which accompanied it, giving detailed application to over 100 sets of data for many materials, is due shortly to appear in the Current Papers series of the Aeronautical Research Council.

A. Graham
K. F. A. Walles

National Gas Turbine Establishment, Farnborough, Hants.

REFERENCE

1. W. Betteridge, *J. Inst. Metals*, 1957–58, **86**, (5), 232.

The points made by Mr. Graham and Mr. Walles in their letter are fully appreciated, but it must be borne in mind that all the creep formulæ examined are purely empirical in nature, and therefore the sole test of their serviceability is whether they will satisfy the immediate requirements. The work reported in my paper referred to a particular group of alloys, all of a similar type, whereas the work of Graham and Walles has referred to a much wider variety of materials.

It must also be remembered that the usefulness, from a practical point of view, depends to some extent on the ease of applicability. There is little doubt that the Manson and Haferd method is more easily applied than the Graham and Walles method, and if both give equally satisfactory results the simpler one is to be preferred.

W. Betteridge

The Mond Nickel Co., Ltd., London, S.W.1.

JOINT ACTIVITIES

The British Group for Engineering Applications of Automation

The study of the techniques, machines, and concepts of automation, automatic control, and computation has been intensified in recent years, and interest has been aroused in all branches of science and industry. It was this wide spread of interest which led to a decision to set up an organization, to be known as the British Conference on Automation and Computation, to facilitate the exchange of information regarding the activities of the individual societies within the whole subject.

This new organization has been divided into three groups:

A—The British Group for the Engineering Applications of Automation.

B—The British Group for Computation and Automatic Control.

C—The British Group for the Sociological and Economic Aspects of Automation Techniques.

After a series of preparatory meetings, a meeting was held on 20 February 1958, at which Group A was formally constituted. At present, the Group consists of about twenty societies, including the Institute of Metals.

The objects of the Group are:

(*a*) To foster the development of the engineering applications of automation.

(*b*) To afford a common meeting ground for the adhering organizations, whereby such of their activities as fall within the purview of the Group can, if so desired, be co-ordinated and extended.

(*c*) To maintain, as may be desirable, liaison with other Groups of the British Conference on Automation and Computation by direct contact and by representation on the General Committee of the British Conference.

(*d*) To encourage and, if desired, to co-ordinate the presentation, at International Conferences, of British papers whose subjects fall within the purview of the Group.

(*e*) Through the General Committee of the British Conference on Automation and Computation, to maintain, as may be desirable, liaison with the corresponding National Committees of other countries which support such International Conferences.

Dr. D. F. Galloway, a Member of Council of the Institution of Mechanical Engineers, was elected Chairman of the Group, with Mr. J. S. Brough and Sir Walter Puckey as Vice-Chairmen. Mr. Brian G. Robbins (Secretary of the Institution of Mechanical Engineers) was elected Honorary Secretary of the Group, and the offer of the Institution of Mechanical Engineers to provide secretarial services for the Group was accepted.

The constitution of the Group provides for an Executive Committee, to which are elected, in addition to the Honorary Officers of the Group mentioned above, representatives of nine societies, one of which is the Institute of Metals.

There is also to be a General Committee of the British Conference on Automation and Computation, made up of three representatives of each Group, to provide liaison between the three Groups.

At the meeting of the Engineering Applications Group held on the 20 February 1958 it was agreed that a symposium on

" Instrumentation and Computation in Process Development and Plant Design ", which is being planned jointly by the Institution of Chemical Engineers, the Society of Instrument Technology, and the British Computer Society, should be held under the ægis of the B.C.A.C., subject to the agreement of Group B. Among other points discussed were the possibility of Group participation in the Fourth International Exposition and Congress on Automation in New York during June 1958, relations with the International Federation of Automatic Control and other international organizations of interest, the publication of a *Bulletin*, and the need for a bibliography.

OTHER NEWS

Summer School on Underground Corrosion and Cathodic Protection

The fifth Summer School on Corrosion, arranged by the Battersea College of Technology in conjunction with the Corrosion Group of the Society of Chemical Industry, will be on the subject of " Underground Corrosion and Cathodic Protection ". It will be held at the College on 14–18 July 1958, and will consist of a series of lectures supplemented by a demonstration of instruments and a visit to a site where an underground pipe is being installed.

The inclusive fee for the course is £12, and applications to take part should be sent not later than 1 July to: The Secretary (Summer School), Battersea College of Technology, Battersea Park Road, London, S.W.11.

Fifth International Galvanizing Conference

The International Galvanizing Conference is being held this year under the auspices of the Brussels Universal Exhibition, and will take place at Scheveningen on 22–23 June and at Knokke-le-Zoute on 24–27 June. Details and a provisional programme may be obtained from the Zinc Development Association, 34 Berkeley Square, London, W.1.

Micro 58

An exhibition of photography with the microscope is being organized by the Royal Microscopical Society and will be held at the Polytechnic, Regent Street, London, W.1, on 23–30 July 1958.

The Society extends a cordial invitation to all photomicrographic workers to take part in this exhibition, which, it is hoped, will be the first of an annual series.

Further information and entry forms may be obtained from the Hon. Secretary, Micro 58, Royal Microscopical Society, Tavistock House South, Tavistock Square, London, W.C.1.

International Symposium on Nuclear Electronics

The Société des Radioélectriciens is organizing a Symposium on " Nuclear Electronics " to be held at UNESCO House, Paris, on 16–20 September 1958. Details may be obtained from the Société des Radioélectriciens, 10, Avenue Pierre Larousse, Malakoff (Seine), France.

Deutsche Gesellschaft für Metallkunde

The annual general meeting of the Deutsche Gesellschaft für Metallkunde will take place this year in Essen from 28 September to 1 October.

APPOINTMENTS VACANT

NOTICE TO AUTHORS OF PAPERS FOR THE "JOURNAL" AND CONTRIBUTORS TO DISCUSSIONS

1. **Papers will be considered for publication from non-members as well as members of the Institute.** They are accepted for publication in the *Journal* and not necessarily for presentation at any meeting of the Institute. MSS. should be addressed to The Editor of the *Journal*, The Institute of Metals, 17 Belgrave Square, London, S.W.1.

2. **Papers suitable for publication** may be classified as:

(*a*) Papers recording the results of original research.

(*b*) First-class reviews of, or accounts of progress in, a particular field.

(*c*) Papers descriptive of works methods, or recent developments in metallurgical plant and practice.

(*d*) Papers in classes (*a*), (*b*), and (*c*) above, previously published in languages other than English, French, German, or Italian, if of sufficient merit.

3. **Manuscripts and illustrations** should be submitted in duplicate. MSS. must be typewritten (*double-line spacing*) on one side of the paper only, and authors are requested to sign a declaration that neither the paper nor a substantial part thereof has been published elsewhere. Exceptions may be made in certain cases where a paper has been published in a language other than English, French, German, or Italian (see 2(*d*) above). MSS. not accepted are normally returned within 6 months of receipt.

In the interests of economy, all papers must be written as concisely as possible; in general, internal research reports are not in suitable form for publication as papers in the *Journal*. All but the simplest mathematical expressions should be written by hand, with capital and small letters clearly distinguished. Superscript and subscript letters should also be plainly indicated. Greek letters and special signs should be identified in the margin. For style, spelling, and abbreviations used, any recent issue of the *Journal* may be consulted.

4. **Abstract.** Every paper must have an abstract (not exceeding 250 words in length) which, in the case of a paper reporting original research, should state its objects, the ground covered, and the nature of the results. The abstract will appear at the beginning of the paper, and should be in a form suitable for use by abstracting organizations. Extracts from a "Guide for the Preparation of Abstracts" drawn up by the Abstracting Services Consultative Committee are reproduced below.

5. **References** must be collected at the end of the paper and must be numbered in the order in which they occur in the MS. Initials of authors must be given, and the Institute's official abbreviations for periodical titles (as used in *Metallurgical Abstracts*) should be employed, where known. References to papers should be set out in the style:

A. L. Dighton and H. A. Miley, *Trans. Electrochem. Soc.*, 1942, **81**, 321 (i.e. year, volume, page).

References to books should be in the following style:

C. Zener, "Elasticity and Anelasticity of Metals". **1948**: Chicago (University of Chicago Press).

6. **Illustrations.** Each illustration must have a number and description; only one set of numbers must be used in one paper. The captions should be typed on a separate sheet.

The set of **line figures** sent for reproduction must be drawn (about twice the size to appear in the *Journal*) in Indian ink on smooth white Bristol board, good-quality drawing paper, co-ordinate paper, or tracing *cloth*, which are preferred in the order given. Co-ordinate paper, if used, must be blue-lined with the co-ordinates to be reproduced finely drawn in Indian ink. Curves should be drawn boldly (i.e. at least twice the thickness of the frame). Experimental points should be indicated by open or closed circles, triangles, squares, &c. (preferably not crosses). Curves should be broken on each side of such symbols and plenty of allowance should be made for closing up in blockmaking. The Institute's standard lettering will be affixed, and ample margins must be left outside the framework of the figures to enable this to be done. The second set of line illustrations may be photostat copies.

Photographs must be restricted in number, owing to the expense of reproduction, and photomicrographs should be trimmed to the smallest possible of the following sizes consistent with adequate representation of the subject: 4 in. deep by 3 in. wide: 2 in. deep by 3 in. wide: 2 in. square. Magnifications of photomicrographs must be given in each case. Photographs for reproduction should be loose, not pasted down (and not fastened together with a clip, which damages them), and the figure number and author's name should be written on the back of each. Captions should be given to the photomicrographs, but these should be kept as brief as possible.

Because of the present high cost of printing and paper, it is imperative that authors restrict illustrations (particularly photographs) to the absolute minimum deemed necessary to support their argument. Only in exceptional cases will illustrations be reproduced if already printed and readily available elsewhere.

7. **Tables or Diagrams.** Results of experiments, &c., may be given in the form of tables *or* figures, *but* (unless there are exceptional reasons) *not both*. Tables should bear Roman numbers, and each should have a heading that will make the data intelligible without reference to the text.

8. **Corrections.** A certain number of corrections in proof are inevitable, but any modification of the original text is to be avoided. Since corrections are very expensive, the Institute reserves the right to require authors to contribute towards their cost if the Editor deems them to be excessive. The Institute also reserves the right to require a contribution to the cost of remaking any block where this is necessitated by an error on the author's part.

9. **Reprints.** Individual authors are presented with a maximum of 25, and two or more authors with a maximum of 50 reprints from the *Journal*, without covers. Limited numbers of additional reprints can be supplied at the author's expense, if ordered before proofs are passed for press. (Orders should preferably be placed when submitting MSS.)

10. **Discussion.** Except in the case of special symposia, shorthand records of discussions are not taken at meetings. Written discussion may be submitted on any paper, preferably typewritten (*double-line spacing*). References should be given in the form of footnotes. Paragraphs 6 and 7 above are also applicable to such contributions. Reprints of discussion cannot be supplied to contributors.

GUIDE FOR THE PREPARATION OF ABSTRACTS

(*As recommended by the Abstracting Services Consultative Committee*)

1. **Purpose.** The abstract is not part of the paper; it is intended to convey briefly the content of the paper, to draw attention to all new information, and to the main conclusions. It should be factual.

2. **Style of writing.** The abstract should be written concisely and in normal rather than abbreviated English. It is preferable to use the third person. Where possible use standard rather than proprietary terms, and avoid unnecessary contracting.

It should be presumed that the reader has some knowledge of the subject, but has not read the paper. The abstract should therefore be intelligible in itself without reference to the paper; for example, it should not cite sections or illustrations by their numerical references in the text.

3. **Content.** The title of the paper is usually read as part of the abstract. The opening sentence should be framed accordingly and repetition of the title avoided. If the title is insufficiently comprehensive, the opening should indicate the subjects covered. Usually the beginning of an abstract should state the objective of the investigation.

It is sometimes valuable to indicate the treatment of the subject by such words as: brief, exhaustive, theoretical, &c.

The abstract should indicate newly observed facts, conclusions of an experiment or argument and, if possible, the essential parts of any new theory, treatment, apparatus, technique, &c.

It should contain the names of any new compound, mineral species, &c., and any new numerical data, such as physical constants; if this is not possible, it should draw attention to them. It is important to refer to new items and observations, even though some are incidental to the main purpose of the paper; such information may otherwise be hidden, though it is often very useful.

When giving experimental results, the abstract should indicate the methods used; for new methods the basic principle, range of operation, and degree of accuracy should be given.

4. **References.** If it is necessary to refer to earlier work in the summary, the reference should always be given in full and not by number. Otherwise references should be left out.

When an abstract is completed, the author is urged to revise it carefully, removing redundant words, clarifying obscurities, and rectifying errors in copying from the paper. Particular attention should be paid by him to scientific and proper names, numerical data, and chemical and mathematical formulæ.